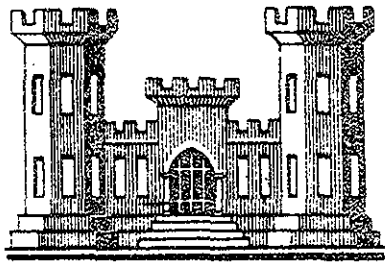
HURRICANE PROTECTION PROJECT

FOX POINT

HURRICANE BARRIER

PROVIDENCE RIVER, PROVIDENCE, RHODE ISLAND

DESIGN MEMORANDUM NO. 14
CONCRETE AGGREGATES



U.S. Army Engineer Division, New England
Corps of Engineers Waltham, Mass.

NOVEMBER 1959

ENGWE(3 Nov 59) 1st Ind
SUBJECT: Design Memorandum No. 14, Concrete Materials, for Fox Point Hurricane Barrier, Providence, Rhode Island

Office of the Chief of Engineers, Washington, D.C., 27 November 1958

TO: Division Engineer, U.S. Army Engineer Division, New England, Waltham, Mass. ATTN: NEDGW

Approved.

FOR THE CHIEF OF ENGINEERS:

1 Incl w/d

F. B. SLICHTER
For Chief, Engineering Division
Civil Works

U. S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM 54. MASS.

ADDRESS REPLY TO:
DIVISION ENGINEER

REFER TO FILE NO. NEDGW

3 November 1959

SUBJECT: Design Memorandum No. 14, Concrete Materials, for Fox Point Hurricane Barrier, Providence, Rhode Island

TO: Chief of Engineers
Department of the Army
Washington, D. C.
ATTENTION: ENGWE

In accordance with EM 1110-2-1150 there is submitted for review and approval 10 copies of the Design Memorandum No. 14, Concrete Materials, for the Fox Point Hurricane Barrier, Providence, Rhode Island.

FOR THE DIVISION ENGINEER:

John Wm. Leslie

JOHN WM. LESLIE
Chief, Engineering Division

Incl (10 cys)
Des Memo No. 14,
Concrete Materials -
Fox Point

FOX POINT HURRICANE BARRIER
PROVIDENCE
RHODE ISLAND

DESIGN MEMO NO. 14

CONCRETE MATERIALS

INDEX TO DESIGN MEMORANDA

No.	Title	Submission Date	Approved
1	Geology	9 Oct 1959	
2	Hydrology Preliminary Final	3 June 1959	8 June 1959
3	Deleted		
4	Hurricane Tidal Hydraulics		
5	General Design Memo		
6	Embankment & Foundations		
7	Structural Section I		
8	Structural Section II		
9	River Gates		
10	Pumping Station		
11	Cooling Water Canal		
12	Sewer & Utility Modifications		
13	Providence River Studies		
14	Concrete Materials		

FOX POINT HURRICANE BARRIER

DESIGN MEMORANDUM NO. 14

CONCRETE MATERIALS

CONTENTS

LIST OF PLATES

LIST OF TABLES

U. S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM 54, MASSACHUSETTS

FOX POINT HURRICANE BARRIER

PROVIDENCE RIVER

RHODE ISLAND

DESIGN MEMORANDUM NO. 14

CONCRETE MATERIALS

OCTOBER 1959

A. AGGREGATES

1. General. Approximately 55,000 cubic yards of concrete will be required for construction of the barrier, pumping station, and floodwalls of the Providence Hurricane Protection Project. In view of the relatively small quantity of aggregates and the absence of undeveloped sources on the site, investigations have been confined to established commercial sources. All of the three commercial sources within a 15-mile radius of the project site have been recently investigated and tested. A fourth commercial source, although at a distance of 100 miles, is considered because of its high quality aggregate and economic availability. A fifth commercial source, which was only recently developed, is presently being investigated and tested, and the results will be issued as an addendum to this design memorandum. Locations of these sources are shown on Plate No. XIV-1.

2. Investigations. Selection of the sources for testing was based on plant facilities and characteristics of materials as determined by visual examination. All of the natural sand and gravel sources investigated are developed in Pleistocene glacial outwash deposits and exhibit a lithological similarity. The Fanning and Doorley Quarry (crushed stone) is developed in igneous rock of the Devonian age. The New Haven Trap Rock Quarry is developed in igneous rock of the Triassic age.

3. Tests. Representative samples of the aggregates have been tested for evaluation. Results of the aggregate tests are summarized in Tables XIV-1 and XIV-2.

4. Relative Cost Estimates. Estimated delivered prices of the aggregates, based on quoted plant prices, Rhode Island Department of Public Utilities minimum trucking rates, which are currently 25 cents

per ton for the first mile and 5 cents per ton for each additional mile, and current railway shipping charges, are as follows:

a. Romano Sand and Gravel Company. The nearest commercial source is the Romano Sand and Gravel Company with its main processing plant located at East Providence, Rhode Island, about 4 miles haul distance from the project site. Plant prices are $1.35/ton for gravel and $0.75/ton for sand. The delivered price to the site will average $1.75/ton for gravel and $1.15/ton for sand.

b. Morse Sand and Gravel Company. The Morse Sand and Gravel Company, with its main processing plant located in Dodgeville, Massachusetts, about 10 miles haul distance from the project site. Plant prices are $1.35/ton for gravel and $1.00/ton for sand. The delivered price to the site will average $2.05/ton for gravel and $1.70/ton for sand.

c. Fanning and Doorley Construction Company. The Fanning and Doorley Construction Company has its main quarry located at Ashton, Rhode Island, about 12-mile haul distance from the project site. Plant prices for crushed stone range from $2.15/ton to $2.55/ton. The delivered price to the site will average $3.15/ton.

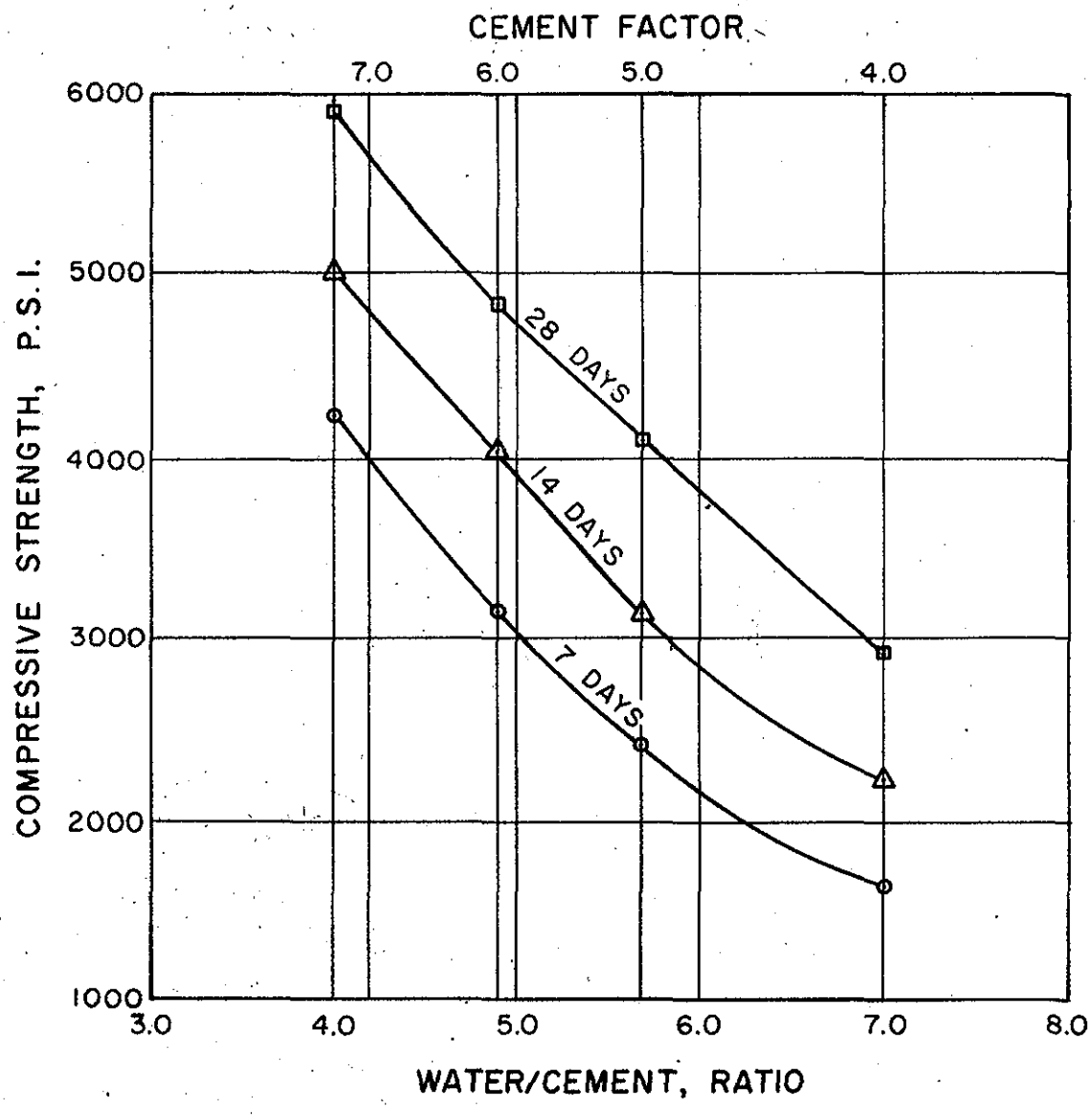
d. New Haven Trap Rock Company. The New Haven Trap Rock Company has its main quarry located at North Bradford, Connecticut, about 100 miles rail distance from the project site. Plant prices for crushed stone average $1.40/ton. The delivered price to the site will average $2.25/ton.

e. M. A. Gammino Company. The M. A. Gammino Company has its quarry and processing plant located at Cranston, Rhode Island, about 6 miles haul distance from the project. *Plant prices for crushed stone average $1.80/ton. The delivered price to the site will average $2.30/ton.*

f. Rhode Island Sand and Gravel Company. The Rhode Island Sand and Gravel Company, with its main processing plant located in Warwick, Rhode Island, about 7 miles haul distance from the project site. Plant prices for concrete sand are $1.05/ton. The delivered price to the site will average $1.55/ton.

B. WATER

5. General. The concrete in this waterfront structure will be subjected to the contaminated water in the Providence River, which is a tidal estuary. Therefore, it was deemed necessary to investigate this water so that the necessary protection can be provided. A comprehensive sampling and testing program has been conducted by Bureau of Public Health in connection with other phases of the design studies. In addition, a separate detailed sampling and testing program has been conducted in connection with an investigation of corrosion properties of the water and river mud. Samples were obtained at the high, low, and mean tides, three feet from the water surface and three feet from the bottom and at various other elevations.



M. A. GAMMINO COMPANY, COARSE AGGREGATE
RHODE ISLAND SAND AND GRAVEL COMPANY, FINE AGGREGATE

FOX POINT BARRIER
PROVIDENCE, RHODE ISLAND

PLATE XIV-4

ITEM NUMBER	SOURCE AND LOCATION	REMARKS AND SOURCE	HAUL IN MILES	MATERIAL TESTED (PROCESSED)	NORMAL SIZE	TESTING LABORATORY AND DATE OF TESTS	SAMPLE NUMBER	SIEVE ANALYSIS OF AGGREGATE PERCENT PASSING - BY WEIGHT														FINENESS MODULUS	L.A. ABRASION TEST 500 REVOLUTIONS PERCENT LOSS	SOUNDNESS TEST 5 CYCLES - $MgSO_4$ PERCENT LOSS	ORGANIC IMPURITIES (PPM) ASTM PLATE I	MORTAR STRENGTH PERCENT OF STANDARD			FLAT AND ELONGATED PARTICLES PERCENT BY WEIGHT	ALKALI REACTIVITY	DELETERIOUS MATERIALS	ABSORPTION PERCENT	SPECIFIC GRAVITY			COMPRESSIVE STRENGTH - PSI									LINEAL COEFFICIENT THERMAL EXPANSION X10 - 6/°F	DURABILITY FACTOR (DFE) 300 CYCLES
								SIEVE SIZE IN INCHES							U.S. STANDARD SIEVES NUMBERS																														
								2½	2	1½	1	¾	½	⅜	4	8	16	30	50	100	200					3 DAY	7 DAY	28 DAY					BULK	BULK S.S. DRY	APPARENT	7 DAY AVERAGE			14 DAY AVERAGE			28 DAY AVERAGE				
																																				CEMENT FACTOR			CEMENT FACTOR			CEMENT FACTOR				
																																			5.0	6.0	7.0	5.0	6.0	7.0	5.0	6.0	7.0		
1	N.A. Gammino Co. Cranston, R.I.	Operating Quarry	6	Crushed Diorite Gneiss	2" 1 1/2" 3/4" 1/2"	NED December 1960	61-6-1	100	84	27	1	-	-	-	-	-	-	-	-	-	-	8.32		4.0					3.5			0.4	2.82	2.83	2.85	2440	3160	4260	3190	4030	5030	4110	4860	5900		
							61-6-2	-	-	100	67	10	1	-	-	-	-	-	-	-	-	7.28							8.9			0.6	2.77	2.79	2.82											
							61-6-3	-	-	-	100	89	29	6	1	1	-	-	-	-	-	6.87	28	3.1					8.4	Innoc	None	0.8	2.78	2.80	2.85											
							61-6-4	-	-	-	-	-	100	95	26	4	2	-	-	-	-	5.78		4.1					9.4			1.4	2.73	2.77	2.84										5.2*	66*
2	Rhode Island Sand & Gravel Co. Warwick, R.I.	Operating Pit in glacial outwash deposits	7	Natural Sand	No. 4		61-5-1	-	-	-	-	-	-	-	100	88	66	43	13	3	1.2	2.87	-	5.9	500	-	121	139		Innoc	None	0.7	2.62	2.63	2.66											

PETROGRAPHIC ANALYSIS

1. Predominately Quartz Gneiss, Schist, Vein Quartz and Pegmatite. 79% Diorite Gneiss, 16% Schist, 5% Vein Quartz and Pegmatite, 10% moderately weathered.

2. Is composed 73% Quartz and Quartzite, 19% Granite and Pegmatite, 4% Gneiss, 2% Schist, and 2% Basic Rock Types, 1% moderately weathered.

* Tested February 1960 by SAD Laboratories

PROVIDENCE LOCAL PROTECTION
FOX POINT BARRIER
PROVIDENCE R. I.

CONCRETE AGGREGATE INVESTIGATION
TEST DATA SUMMARY

NEW ENGLAND DIVISION LABORATORIES
CORPS OF ENGINEERS NEW ENGLAND DIVISION
WALTHAM, MASS. DECEMBER 1960

TABLE XIX - 3

per ton for the first mile and 5 cents per ton for each additional mile, and current railway shipping charges, are as follows:

a. Romano Sand and Gravel Company. The nearest commercial source is the Romano Sand and Gravel Company with its main processing plant located at East Providence, Rhode Island, about 4 miles haul distance from the project site. Plant prices are $1.35/ton for gravel and $0.75/ton for sand. The delivered price to the site will average $1.75/ton for gravel and $1.15/ton for sand.

b. Morse Sand and Gravel Company. The Morse Sand and Gravel Company, with its main processing plant located in Dodgeville, Massachusetts, about 10 miles haul distance from the project site. Plant prices are $1.35/ton for gravel and $1.00/ton for sand. The delivered price to the site will average $2.05/ton for gravel and $1.70/ton for sand.

c. Fanning and Doorley Construction Company. The Fanning and Doorley Construction Company has its main quarry located at Ashton, Rhode Island, about 12-mile haul distance from the project site. Plant prices for crushed stone range from $2.15/ton to $2.55/ton. The delivered price to the site will average $3.15/ton.

d. New Haven Trap Rock Company. The New Haven Trap Rock Company has its main quarry located at North Bradford, Connecticut, about 100 miles rail haul distance from the project site. Plant prices for crushed stone average $1.40/ton. The delivered price to the site will average $2.25/ton.

e. M. A. Gammino Company. The M. A. Gammino Company has its quarry and processing plant located at Cranston, Rhode Island, about 7 miles haul distance from the project. This source will be in economic competition with the other sources.

B. WATER

5. General. The concrete in this waterfront structure will be subjected to the contaminated water in the Providence River, which is a tidal estuary. Therefore, it was deemed necessary to investigate this water so that the necessary protection can be provided. A comprehensive sampling and testing program has been conducted by Bureau of Public Health in connection with other phases of the design studies. In addition, a separate detailed sampling and testing program has been conducted in connection with an investigation of corrosion properties of the water and river mud. Samples were obtained at the high, low, and mean tides, three feet from the water surface and three feet from the bottom and at various other elevations.

6. Tests. Typical results of laboratory tests performed on the samples of river water taken three feet from the top and bottom are as follows:

Tests	Test Results (Parts per Million)(1) Low Tide Top	Low Tide Bottom	Mean Tide Top	Mean Tide Bottom	High Tide Top	High Tide Bottom
pH	7.4	7.4	7.9	7.3	8.3	7.6
Turbidity	40	3	50	2	70	8
Free Carbon Dioxide	11.5	14.3	2.0	12.0	0.0	6.5
Alkalinity (as $C_aCO_,$)						
Total	98	100	96	105	97	103
Carbonate	0	0	0	0	23	0
Bicarbonate	98	100	96	105	74	103
Hydroxide	0	0	0	0	0	0
Free Mineral Acid	0	0	0	0	0	0
Total Hardness (as C_a CO_3)	4,000	5,250	4,200	5,550	4,600	5,000
Ferrous Iron, Total	0	0	0	0	0	0
Ferric Iron Total	0.44	0.28	0.44	0.20	0.40	0.30
Dissolved	0.02	0.02	0.02	0.02	0.04	0.02
Suspended	0.42	0.26	0.42	0.18	0.36	0.28
Sulfides as $S^=$	0.05	0.05	0.05	0.05	0.05	0.05
Silica	2.2	3.2	1.0	1.6	1.0	0.04
Sulphates	1,750	2,310	1,880	2,290	1,980	2,230
Chlorides	12,750	16,870	13,650	16,890	14,500	16,150
Manganese	0	0	0	0	0	0
Solids, Total	23,520	31,200	25,370	32,650	27,980	31,720
Staining	Severe	Severe	Severe	Severe	Severe	Severe

(1) Except for pH.

C. FOUNDATION SOILS

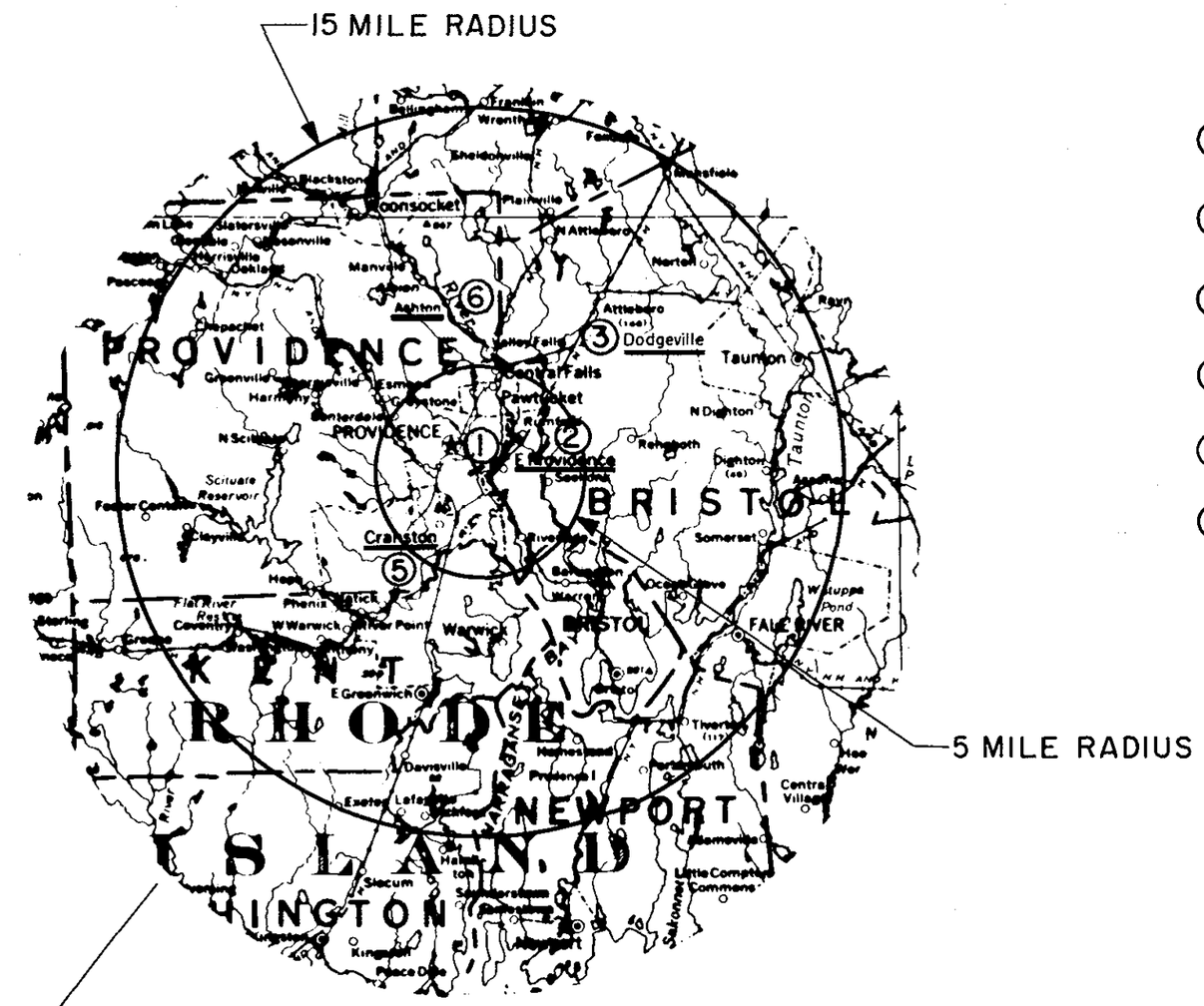
The foundation materials consist of organic silts in the river, and fill material on the abutments which consist in part of unburned coal and coal ashes. The bedrock contains the Rhode Island Series which is, in part, carboniferous. Tests on the mud indicate a sulfide content in excess of 2,000 p.p.m. Based on these data, it is considered that potentially reactive material is present in the foundation soils.

D. CONCLUSIONS AND RECOMMENDATIONS

Based on the data presented herein, the durability of the crushed quarry stone coarse aggregates is substantially greater than for the gravel coarse aggregate. However, all of the aggregates tested are considered acceptable for use in the proposed structure and approval of these sources is recommended.

Tests performed on the river water show that the sulfate content exceeds the maximum limit (1000 ppm) permitted by Civil Works Bulletin ENGWE 56-18 for Type II cement. Therefore, in accordance with this bulletin, Type V cement is required for the exposed portions of the structure. However, due to the relatively small quantity of concrete required and difficulty in handling two types of cement, it is recommended that Type V cement be used throughout. This would include use in any concrete piles because of the potential reactivity of the foundation soils.

No consideration is given to use of the river water for either mixing or curing concrete. Water for these uses will be obtained from the City water supply or other acceptable source.



① Fox Point Barrier

② L. Romano Sand & Gravel Co.

③ Morse Sand & Gravel Co.

④ New Haven Traprock Co.

⑤ M. A. Gammino Co.

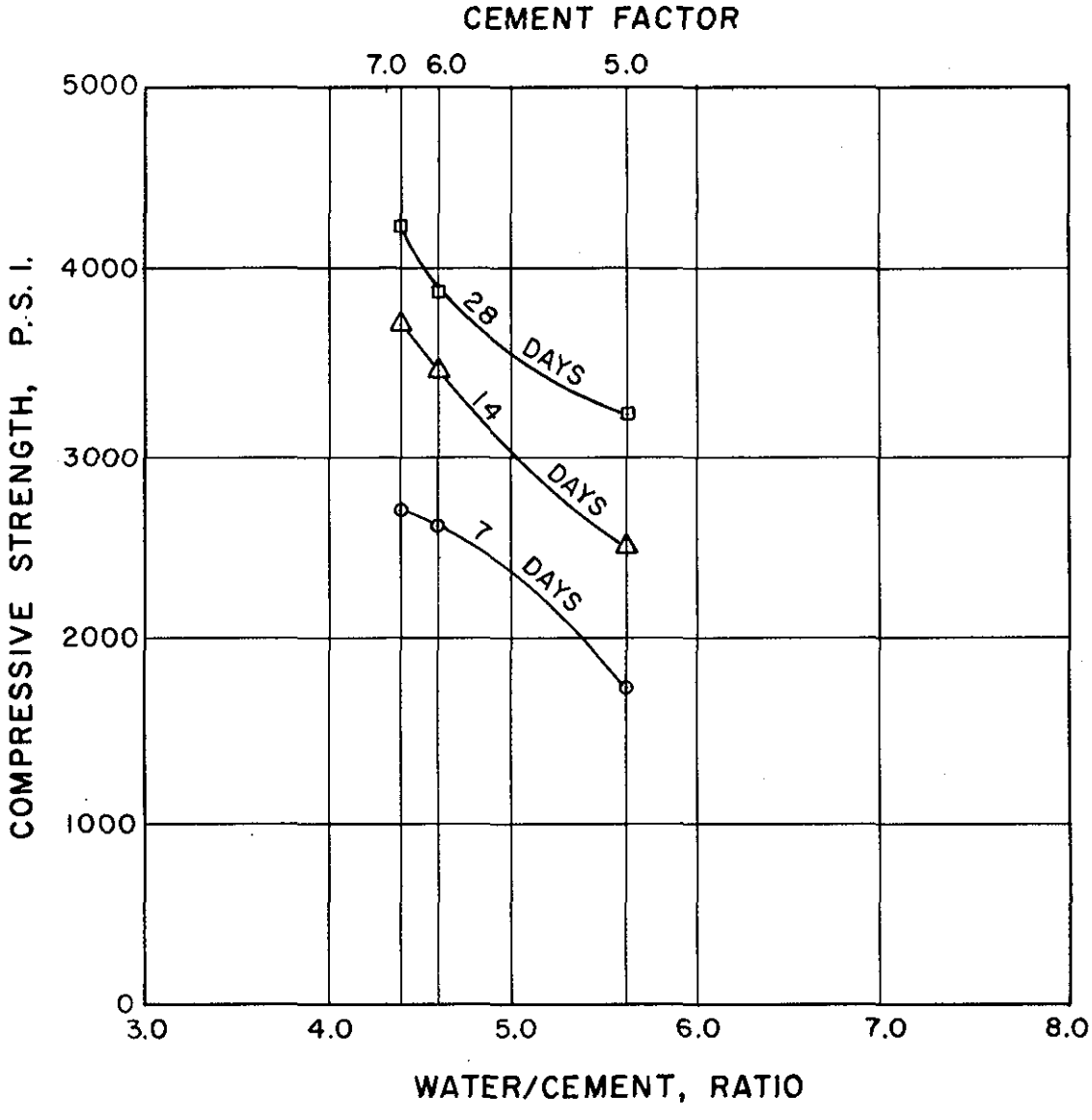
⑥ Fanning & Doorley

PROVIDENCE LOCAL PROTECTION
FOX POINT BARRIER
PROVIDENCE, R.I.

LOCATION OF COMMERCIAL AGGREGATE SOURCES

NEW ENGLAND DIVISION LABORATORIES
CORPS OF ENGINEERS NEW ENGLAND DIVISION
WALTHAM, MASS. OCT. 1959

PLATE XIV - 1

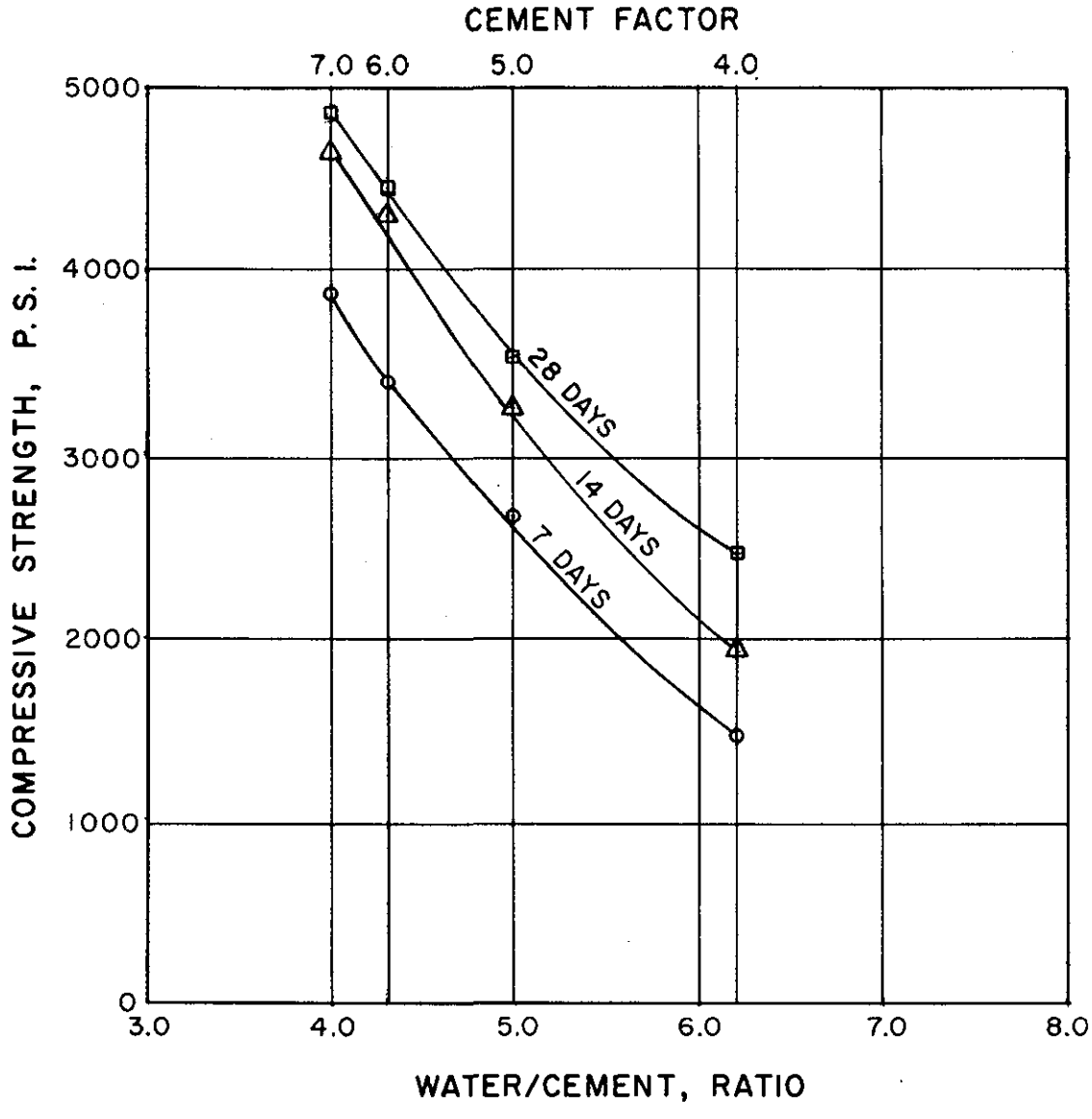


ROMANO SAND AND GRAVEL CO., AGGREGATES

FOX POINT BARRIER

PROVIDENCE, RHODE ISLAND

PLATE XIV-2



MORSE SAND AND GRAVEL CO., AGGREGATES

FOX POINT BARRIER
PROVIDENCE, RHODE ISLAND

PLATE XIV-3

ITEM NUMBER	SOURCE AND LOCATION	REMARKS AND SOURCE	HAUL IN MILES	MATERIAL TESTED (PROCESSED)	NORMAL SIZE	TESTING LABORATORY AND DATE OF TESTS	SAMPLE NUMBER	Sieve Analysis of Aggregate Percent Passing - by Weight: SIEVE SIZE IN INCHES 2½	2	1½	1	¾	½	⅜	U.S. STANDARD SIEVES NUMBERS 4	8	16	30	50	100	200	FINENESS MODULUS	L.A. ABRASION TEST 500 REVOLUTIONS PERCENT LOSS	SOUNDNESS TEST 5 CYCLES - $MgSO_4$ PERCENT LOSS	ORGANIC IMPURITIES (PPM) ASTM PLATE I	MORTAR STRENGTH PERCENT OF STANDARD 3 DAY	7 DAY	28 DAY	FLAT AND ELONGATED PERCENT BY WEIGHT	ALKALI REACTIVITY	DELETERIOUS MATERIALS	ABSORPTION PERCENT	SPECIFIC GRAVITY BULK	BULK SS DRY	APPARENT	Compressive Strength PSI * 7 DAY AVERAGE CEMENT FACTOR 5.0	6.0	7.0	14 DAY AVERAGE CEMENT FACTOR 5.0	6.0	7.0	28 DAY AVERAGE CEMENT FACTOR 5.0	6.0	7.0	LINEAL COEFFICIENT THERMAL EXPANSION X10 — 6/F	DURABILITY FACTOR (DFE) 300 CYCLES
1.	Romano Sand & Gravel Co. E. Providence, R.I.	Operating pit in glacial outwash deposits	4	Natural Gravel	2-1/2" 1-1/2" 3/4" 3/8"	S. A. D. March 1959	82-579	-	100	96	72	14	1	-	-	-	-	-	-	-	-	7.90	24	3.4					7	Innoc	None	0.8	2.69		1768	2598	2669	2451	3505	3745	3225	3832	4224	6.2	54
							82-578	-	-	100	71	17	4	-	-	-	-	-	-	-	-	7.83										0.8	2.68												
							82-577	-	-	-	100	91	20	2	1	-	-	-	-	-	-	7.06										0.7	2.68												
							82-576	-	-	-	-	-	100	94	16	11	-	-	-	-	-	5.79										1.2	2.65												
2.				Natural Sand	No. 4		82-575	-	-	-	-	-	-	-	100	83	58	37	18	6	2	2.98	-	15.2	<500			104	9	Innoc	None	1.2	2.66										5.4	
3.	Morse Sand & Gravel Co. Dodgeville, Mass.	Operating pit in glacial outwash deposits	10	Natural Gravel	2-1/2" 1-1/2" 1" 3/4" 3/8"	S. A. D. March 1959	82-574	100	98	64	6	1	-	-	-	-	-	-	-	-	-	8.35	17	2.8					8	Innoc	None	0.6	2.64		2650	3390	3774	3416	4379	4373	3915	4350	4838	5.2	46
							82-573	-	-	100	73	43	3	2	-	-	-	-	-	-	-	7.55										0.7	2.68												
							82-572	-	-	100	98	64	2	1	-	-	-	-	-	-	-	7.35										0.6	2.67												
							82-571	-	-	-	-	100	82	43	9	4	-	-	-	-	-	6.34										1.1	2.66												
							82-570	-	-	-	-	-	100	99	13	3	-	-	-	-	-	5.85										1.4	2.66												
4.				Natural Sand	No. 4		82-569	-	-	-	-	-	-	100	99	83	54	26	10	4	2	3.24	-	8.4	<500			117	10	Innoc	None	1.1	2.65										5.1	

Petrographic Analysis

1. Gravel: Predominantly Quartzite, Granite, and basic igneous rocks, with slate & phyllite and miscellaneous rock types. 36% Quartzite, 19% Granitic Rock Types, 19% Basic Rock Types, 13% Slate & Phyllite, 7% Conglomerate, 4% Veinquartz, 2% Miscellaneous, 18% weathered.
2. Sand: Is composed of 66% Quartz and Quartzite, 7% Granitic Rock Types, 9% Basic Rock Types, 9% Slate & Phyllite, 4% Feldspar, 5% Miscellaneous.
3. Gravel: Predominantly Granitic Rock Types, Quartzite and basic igneous rocks, and miscellaneous rock types. 31% Granitic Rock Types, 20% Basic Rock Types, 17% Slates, Phyllite, and Schist, 20% Quartzite, 9% Conglomerate, 3% Miscellaneous, 9% Moderately weathered.
4. Sand: Is composed 58% Quartz & Quartzite, 11% Granitic Rock Types, 9% Basic Rock Types, 8% Slate, Phyllite & Schist, 8% Feldspar, 5% Miscellaneous.

* Compressive Strength Tests by NED Laboratory

PROVIDENCE LOCAL PROTECTION
FOX POINT BARRIER
PROVIDENCE R.I.

CONCRETE AGGREGATE INVESTIGATIONS
TEST DATA SUMMARY

NEW ENGLAND DIVISION LABORATORIES
CORPS OF ENGINEERS NEWENGLAND DIVISION
WALTHAM, MASS. OCT 1959

TABLE XIV - 1

ITEM NUMBER	SOURCE AND LOCATION	REMARKS AND SOURCE	HAUL IN MILES	MATERIAL TESTED (PROCESSED)	NORMAL SIZE	TESTING LABORATORY AND DATE OF TESTS	SAMPLE NUMBER	Sieve Analysis of Aggregate Percent Passing - by Weight														FINENESS MODULUS	L.A. ABRASION TEST 500 REVOLUTIONS PERCENT LOSS	SOUNDNESS TEST 5 CYCLES - $MgSO_4$ PERCENT LOSS	ORGANIC IMPURITIES (PPM) ASTM PLATE I	MORTAR STRENGTH PERCENT OF STANDARD			FLAT AND ELONGATED PERCENT BY WEIGHT	ALKALI REACTIVITY	DELETERIOUS MATERIALS	ABSORPTION PERCENT	SPECIFIC GRAVITY			Compressive Strength - PSI									LINEAL COEFFICIENT THERMAL EXPANSION X10 - $^{6}/_{^{\circ}F}$	DURABILITY FACTOR (DFE) 300 CYCLES
								SIEVE SIZE IN INCHES							U.S. STANDARD SIEVES NUMBERS																														
								2½	2	1½	1	¾	½	⅜	4	8	16	30	50	100	200					3 DAY	7 DAY	28 DAY					BULK	BULK SS DRY	APPARENT	7 DAY AVERAGE			14 DAY AVERAGE			90 DAY AVERAGE				
																																				CEMENT FACTOR			CEMENT FACTOR			CEMENT FACTOR				
																																				5.5	6.0	6.5	5.5	6.0	6.5	5.5	6.0	6.5		
5.	Fanning & Doorley Quarry Ashton, Rhode Island	Operating Quarry	12	Crushed Granite	2-1/2" 1-1/2" 3/4" 1/2" 3/8"	S. A. D. April 1956 Tested for Woonsocket Local Protection Project	82-229 82-228 82-227 82-226 82-225	100 - - - -	92 - - - -	43 - - - -	- 100 100 - -	- 61 95 100 -	- 23 8 88 100	- 4 2 20 95	- 3 - 1 24	- - - - 2	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -	8.54 7.74 7.03 6.79 5.79	22	0.9						11 11 13 22 13	Innoc	None	0.4 0.2		2.67												4.3	79
6.	New Haven Trap Rock Co. North Bradford, Conn.	Operating Quarry	101	Crushed Diabase	2" 1" 3/4" 1/2" 3/8"	O. R. D. February 1955 Tested for Boston Army Base	55228	100 - - - -	99 - - - -	43 - - - -	1 100 100 - -	- 71 99 - -	- 27 29 100 -	- 1 3 38 100	- - 2 2 77	- - - - 12	- - - - 10	- - - - 10	- - - - 9	- - - - 8	- - - - -	8.57 7.73 6.96 6.60 4.74	13.5						7 16	Innoc	None	0.8		2.93		3710	4680	5890	4705	5600	6880	4240	5345	6580	3.4	86

Petrographic Analysis

5. Granite: Predominantly quartz with some feldspar and plagioclase, mica-biotite and muscovite and miscellaneous materials. 54% quartz, 36% feldspar, orthoclase and plagioclase, 9% mica-biotite and muscovite and 1% miscellaneous materials.

6. Diabase: All of this sample consists of a dark-greenish-black, fine-grained, basic igneous rock with composition and texture of a diabase, 100% diabase.

Note: Durability of Fanning and Doorley Quarry crushed granite computed with fine aggregate from Wrentham Sand and Gravel Co., Wrentham, Mass., and New Haven Trap Rock diabase computed with fine aggregate from Bradford Weston, Inc., Hingham, Mass.

PROVIDENCE LOCAL PROTECTION
FOX POINT BARRIER
PROVIDENCE R.I.

CONCRETE AGGREGATE INVESTIGATIONS
TEST DATA SUMMARY

NEW ENGLAND DIVISION LABORATORIES
CORPS OF ENGINEERS NEW ENGLAND DIVISION
WALTHAM, MASS. OCT 1959

TABLE XIV-2